Statement of Verification

EU Environmental Technology
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Verification Body		**Proposer**	
Name:	ETA-Danmark A/S	Name:	Inray Oy Ltd
Contact:	Thomas Bruun	Contact:	Mika Muinonen
Address	Göteborg Plads 1 DK-2150 Nordhavn	Address:	Teollisuuskatu 2-6 50130 Mikkeli Finland
Telephone:	+45 72 24 59 00	Telephone:	+358 50 3509071
E-mail:	tb@etadanmark.dk	E-mail:	mika.muinonen@inray.fi
Web:	www.etadanmark.dk	Web:	www.inray.fi

Signed,

Thomas Bruun, CEO
Verification Responsible

Janne Kovanen, CEO
Proposer

INSP Reg. Nr. 9099
Medlem af EA MLA

Verified according to the ISO Standard 14034
on Environmental Management:
Environmental Technology Verification

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https://ec.europa.eu/environment/ecoap/etv

This Statement of Verification summarises the main results from the verification of FUELCONTROL®.

The verification was performed under the EU Environmental Technology Verification (ETV) Pilot Programme. The EU ETV Pilot Programme was established to help innovative environmental technologies reach the market by providing a framework for independent evaluation of the performance of such technologies.

This verification was undertaken by the Danish verification body, ETA-Danmark A/S. ETA-Danmark is accredited by the Danish Accreditation body, DANAK, according to EN 17020 for performing environmental technology verifications. This Statement of Verification is available on the website of the EU ETV Pilot Programme: http://iet.jrc.ec.europa.eu/etv/verified-technologies

1 TECHNOLOGY DESCRIPTION

The technology FUELCONTROL® to be verified is a real-time measurement system, which continuously measures the quality of solid fuels using X-ray technology. The system determines fuel moisture concentration, detects foreign objects and can calculate foreign matter concentrations and energy content, when transported by a conveyor belt or conveyor scraper.

The system produces real-time fuel quality data that can be utilized in e.g. fuel pricing and process optimization.

General data

- Operation temperature: -30°C to 45°C
- Material thickness on the conveyor: 100 – 600 mm
- Conveyor type and capacity: scraper or belt 100 – 1000 m³/h
- Solid biofuels (forest residues, stem wood chips, whole wood chips, bark, saw dust, recycled wood, cutter chips and peat)
- Moisture range 10-75 w-%
- Predicted performance for moisture: ±2-5 w-% (depending the fuel type)
- Typical availability of the measurement system is better than 97 %.

The FUELCONTROL® is applicable for medium-sized and large power plants, fuel suppliers, and bio-refineries who wish to improve their production.

2 APPLICATION

2.1 Matrix

The matrix is solid biofuels transported on a conveyer. The biofuels are: Forest residues, bark and saw dust.

2.2 Purpose

The purpose of FUELCONTROL® is to measure fuel moisture content and to detect foreign objects and register its size in real time, when the biofuel is transported by a conveyor, to optimize power plants processes (fuel mixing, combustion), to take preventive measures regarding poor-quality fuels and large foreign objects, and to give a more reliable basis for the fuel pricing.

2.3 Conditions of operation and use

The solid biofuels must be present in a form and size as chips and sawdust and must be transported on a conveyer belt or a conveyer scraper, where the FUELCONTROL® are mounted above the conveyer. Detection of moisture and foreign objects depends on width and depths of the fuel layer on the conveyer, and the initial performance claims is for a fuel depth up to 600 mm.

2.4 Verification parameters definition summary

The performance parameters for the verification are defined by the measured parameters and calculated values by the FUELCONTROL® and for the verification the main parameters are moisture content and detection of large foreign objects of stone and steel.

The moisture parameter is measured by comparing the average FUELCONTROL® measurement for minimum 5 truckloads, each with minimum 100 m³ of biofuel, against the average of 6 manual samples from each of the truckloads.

The detection of foreign objects is defined by detection of added stone and metal to the fuel on the conveyer before the FUELCONTROL® measuring. The size of the added stones and metals is defined as follows:

- Stones large enough to be collected on a 45 mm sieve
- Steel and metal pieces at least the size of an M16 nut.

3 TEST AND ANALYSIS DESIGN

3.1 Existing and new data

No existing data has been used directly in the present verification but have been used to document the performance of the FUELCONTROL®. Statistical evaluation of existing data has showed:

1. Moisture variation within truckloads of the same type of fuel form the same site and supplier could have big variations, up to 10 percentage points.
2. By average the FUELCONTROL® results was on the same level as the samplings.
3. When handling biofuels with low moisture content, the FUELCONTROL® measurements seems to be somewhat higher than the analysis on manual samplings, and the opposite for biofuels with high moisture content.

3.2 Laboratory or field conditions

The verification test was performed at the TSE Oy power Plant in Naantali In Finland, which has three FUELCONTROL® systems in operation. The one used for the verification tests is situated over the conveyer scraper transporting the fuel from the truck unload station up into the fuel silo.

The tests were performed in November 2018 from Monday 5th to Friday 9th.

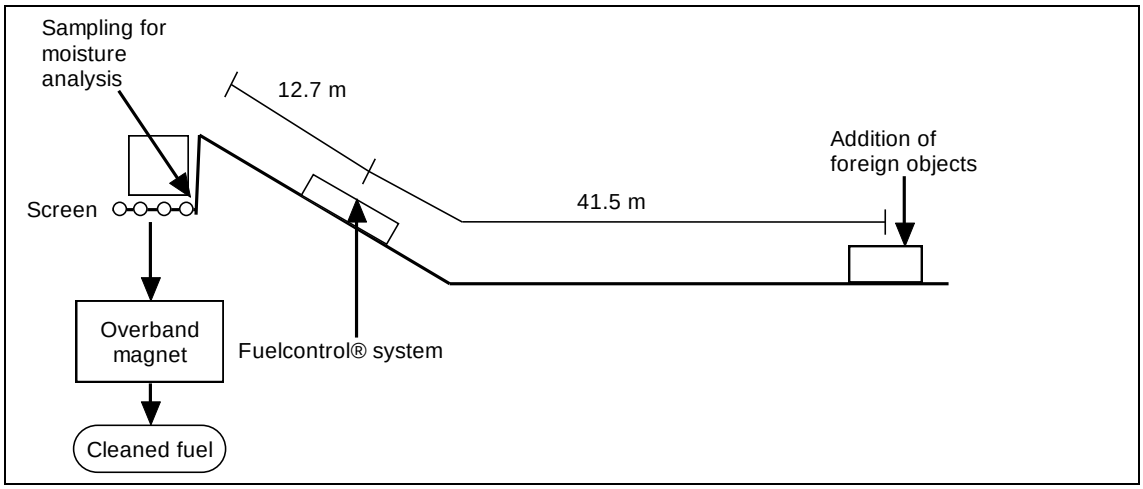

Figure 1. Positions for sampling, addition of foreign objects and FUELCONTROL® system

The test plan for moisture samples and analysis is listed in Table 1:

Table 1. Proposed number of truck unloads and manual sampling

Fuel type	Number of trucks	Samples / truck	Total number of samples
Forest residues	9	6	54
Bark	6	6	36
Saw dust	6	6	36
Total	21	-	126

Test of the detection of foreign objects are made by adding 10 stones size 45 - 62 mm, and 15 magnetic metals M16 nuts. The size and weight of the stones and nuts are measured, and they are marked with a colour and a number, so they can be recognised when they are sorted out from the fuel by a magnet. The stones will not be sorted out, and they will end up in the boiler bottom ash.

3.3 Matrix compositions

The TSE OY Power Plant has a large consumption of fuel, so many trucks are delivered daily with the types of biofuel to be used for the test. The test conditions were the normal operational conditions for the plant where trucks are unloaded to the feeding system when they arrive. However, a small break between unloading of trucks was introduced, to be able to separate the FUELCONTROL® measurement for each truckload.

3.4 Test and analysis parameters

Procedure for sampling according to: EN ISO 18135:2017. Solid biofuel - Sampling.
Sample preparation according to: EN14780:2017. Solid Biofuels - Sample preparation.
Analysis of moisture according to: EN ISO 18134-2:2017. Total moisture - Simplified method

3.5 Tests and analysis methods summary

The methods used are described in the test plan and includes:

- Sampling of the biofuels for analysing the moisture content according to EN ISO 18135:2017.
- Analysis of moisture content according to EN ISO 18134-2:2017.
- Testing for foreign objects by manual adding a fixed number of stones and steel nuts to the fuel on the conveyor prior to the FUELCONTROL® measuring place.

3.6 Parameters measured

The parameters measured are:

- Moisture content in 6 representative manual samples of each truckload.
- Continuously measurement of moisture content by the FUELCONTROL®
- Detection of large foreign objects by the FUELCONTROL®, which is registered by pictures.

4 VERIFICATION RESULTS

The average moisture content measured by laboratory analysis on representative manual sampling and results from FUELCONTROL®, and the difference between them are shown in Table 2.

Table 2. Average moisture content in w-%

	Forest residues	Bark	Sawdust
Manual Sampling - Average of all analysis [w-%]	**33.2**	**61.2**	**53.1**
Manual Sampling - Moisture range [w-%]	22.3 - 51.4	59.6 - 63.1	44.5 - 56.9
Manual Sampling - Precision [w-%][1]	2.47	0.57	1.06
FUELCONTROL® - Average of all truck loads [w-%]	**30.5**	**57.9**	**52.9**
FUELCONTROL® - Moisture range [w-%]	21.6 - 51.4	56.5 - 60.2	37.3 - 60.4
FUELCONTROL® - Precision [w-%][2]	2.29	0.28	1.52
Difference: Manual sampling - FUELCONTROL® [w-%]	**2.7**	**3.3**	**0.2**

The measured value for moisture content from the FUELCONTROL® is achieved by a calculation of measured parameters based on a calibration made for each type of biofuel. If the actual fuel differs from the composition used for the calibration, the results will deviate.

Results of test with addition of foreign objects (stones and nuts) are shown in Table 3

[1] Precision calculated according to ISO/EN 18135:2017

[2] Precision calculated using same method as in ISO/EN 18135:2017 but with Vpt=0

Table 3. Identification of foreign objects

Fuel type	Test - truck	Added nuts	Nuts found by FUELCONTROL®			Added stones	Stones found by FUELCONTROL®		
	No.	Number	Number / %		%	Number	Number / %		%
Forest residues	F1	14	12	86		10	8	80	
	F3	15	13	87	**84**	10	6	60	**67**
	F4	15	12	80		10	6	60	
Bark	B1	15	14	93		10	6	60	
	B3	15	10	67	**76**	10	9	90	**67**
	B5	15	10	67		10	5	50	
Sawdust	S1	15	13	87		10	9	90	
	S2	15	14	93	**93**	10	9	90	**86**
	S4	15	14	93		10	10	100	
	S6	28	27	96		14	10	71	
Average all		162	139	85	**86**	104	78	75	**75**

During the test it showed up to be very difficult to add the nuts, and especially the stones, to the biofuel on the conveyor, without rolling somewhat down to the scraper. If they roll completely down to the scraper, they will not be detected by the FUELCONTROL®, because the scraper will shadow for them. This is most likely the reason for the low rate of detection, except for the sawdust, where the stones and nuts will sink a little bit down in the sawdust, which prevent them from rolling. The conclusion is, that the FUELCONTROL® most likely will identify all large foreign objects, which are not shading for by the scraper.

Forest residues	Saw dust	Bark

Figure 2. Pictures of the tested biofuels

5 ADDITIONAL INFORMATION, INCLUDING ADDITIONAL PARAMETERS

The FUELCONTROL® system logged data automatically. However, in some cases there was prolonged periods of unloading due to stops in infeed (especially for infeed of sawdust). In these cases, it was necessary to manually increase the sampling time of the system to obtain all data.

Additional information is found in the verification report.

6 QUALITY ASSURANCE AND DEVIATIONS

The quality of the laboratory analyses where controlled as described in the test report.

A test system audit was performed by ETA-Danmark during the tests in Finland on November 7th, 2018.

The amendments/deviations are shown in Table 5.

Table 4. Amendments and deviations from test plan

Subject	Change	Consequences for test
Moisture analysis standard	EN/ISO 18134 parts 1 changed to EN ISO 18134-1 parts 2	None
Sampling period for moisture	Sampling period decreased to ensure retrieval of all required data/samples	None
Addition period for foreign objects	Addition period decreased to ensure addition of all foreign objects	None
Mixing of foreign objects with fuel	Mixing was not possible except for the natural mixing by the transport system	None